Japanese Patent Application Laid-Open No. 62-271080

Specification

1. Title of the Invention

CHARACTER/GRAPHIC SEPARATING SYSTEM FOR IMAGE INFORMATION

2. Claim for the Patent

A character/graphic separating system which separates image information including mixed characters and graphics into a character area and a graphic area, comprising at least:

a first step of extracting a closed area by tracking a boundary of black pixels included in the image information;

a second step of separating the character area and the graphic area depending on a size of the closed area;

a third step of tracking an inner boundary of the separated graphic area, and extracting an internal area; and

a fourth step of detecting whether or not the extracted internal area includes the black pixel, wherein

the first step to the fourth step are repeated until the black pixels are not detected in the internal area, thereby hierarchically separating the character area and the graphic area.

3. Detailed Description of the Invention

(Industrial Application Field)

The present invention relates to a mixed mode communication of exchanging a document including mixed characters and graphics, and more specifically to a character/graphic separating system of automatically separating the characters and graphics in the image information.

(Conventional Art)

A facsimile communication of transmitting a document by sequentially discriminating the black and white pixels from the start of the document has been commonly used as means for transmitting a document including mixed characters and graphics. However, since data is processed in a pixel unit regardless of characters or graphics in the facsimile communication, there has been a problem of poor transmission efficiency with the facsimile communication.

As an improved communication system from the facsimile communication, there is a mixed mode communication recently developed and attracting attention as a system of separating characters and graphics, and coding the characters by a character code and the graphics in the conventional pixel unit. Since a separated character area is coded by a character code in the mixed mode communication, the transmission efficiency has been largely improved as compared with the conventional system of coding data in a pixel unit, and a document can be edited with a character changed or the position of a character changed on the receiver side.

Figure 1 shows a document including mixed characters and graphics, and the process of separating the characters and the graphics of the document in the conventional mixed mode communication is described below.

(1) For the binary document image of black and white pixels including characters and graphics, data is scanned in the "row" direction (x direction) in, for example, a run length smoothing algorithm, white pixels are converted into black pixels when the run lengths of adjacent white pixels are equal to or lower than a predetermined threshold, and the black pixels are identified as black pixels as is.

(2) The data is processed similarly in the "column" difference (y direction).

(3) The black pixels obtained as the results of the processes in the row and column directions are "ANDed" and a black area is determined.

(4) Furthermore, the size of each closed area as a black area is determined based on a predetermined criterion, and the character and graphic areas are separated by determining the closed area as the character area (area A) and the graphic area (area B) based on the predetermined criterion.

The separated character and graphic areas are transmitted by performing an appropriate coding process.

(Problems to be Solved by the Invention)

However, the conventional character/graphic separating system separates a character and graphic areas only in a two-dimensional method without considering a hierarchical structure, and it is difficult to identify a character in the area B

although there is a character still included in the graphic area (area B) shown in Figure 1.

Especially, when graphics are configured mostly by characters such as the "table", the entire "table" is determined as a graphic area in the conventional character/graphic separating system, and is processed in a pixel (dot) unit. Therefore, as compared with the method of coding data by a character code of a character area, a large amount of data is to be coded in a pixel unit with poor transmission efficiency, thereby incurring the reduction in transmission efficiency and an impossible document edition of characters displayed in a pixel unit.

Therefore, in a document including mixed characters and graphics, there has been an earnest request for a system of separating character and graphic areas as correctly and efficiently as possible, but there has no such systems disclosed.

(Means for Solving the Problems)

The present invention has been developed to solve the above-mentioned problems with the conventional technology, and aims at providing a character/graphic separating system for image information capable of efficiently and correctly separating a character area and a graphic area in a document including mixed characters and graphics.

The feature of the present invention resides in extracting a closed area from input image information in which a document including mixed characters and graphics is converted into a binary image by tracking the boundary of a black area in the image, analyzing (hereinafter referred to as a "topology

analysis") the inclusive relation of each of the extracted closed areas, describing it as a hierarchical tree structure (hereinafter referred to as a "topological structure"), and converting the topological structure into a document structure in which characters and graphics are separated so as to be adapted to the communication system.

The present invention is described below in detail with reference to the attached drawings.

(Configuration and Operation of the Invention)

Figure 2 is a block diagram of the procedure of a system of hierarchically separating characters and graphics according to the present invention. A document 1 which includes mixed characters and graphics is converted into binary black and white data as binary black and white image information by a scanner etc., a closed area is extracted by tracking the boundary of a black area, a topology analysis 2 of analyzing an internal structure of the extracted closed area is performed, and a topological structure 4 describing a hierarchical relationship of each closed area is generated. Furthermore, a structure conversion 5 is performed to easily coding data by separating the topological structure 4 into characters and graphics, and a final document structure is generated, thereby completely separating the characters and graphics.

Mainly described below with reference to an example of an input image shown in Figure 1 is the procedure of a topology analysis 3 and the topological structure 4 as the features of the present invention.

(1) Topology Analysis

The procedure of the topology analysis 3 is described below.

1) A black pixel as a start point is found by a raster scanning process, a boundary of 8 pixels are tracked, and a closed area is extracted. At this time, each boundary coordinate is stored.

2) A media (characters and graphics) are analyzed in the extracted closed area. Figure 3 shows a criterion in determining characters and graphics (for an alphabetical document). Depending on the size of a rectangle enclosing the extracted closed area, the portion with diagonal lines shown in Figure 3 is defined as a character, and other portions are defined as graphics. In this determining criterion, the horizontal contact of a character is also considered, and the thresholds shown in Figure 3 are w_x for the maximum width of a target character, h_x for the maximum height of a target character, and h_n for the minimum height of a target character.

3) When data is determined as a character, the character is sequentially written to the area corresponding to a character node.

4) When data is determined as graphics, a child node having its closed area is generated. When there is a hole as the example shown in Figure 1, a grandchild node having an area inside the inner boundary is generated. An area can be extracted in the method shown in Figure 4. That is, as compared with the target closed area as shown by (a) of Figure 4, the area inside the outer boundary is regarded as a set of lines enclosed by the two points (x_{ia}, y_j) and (x_{ie}, y_j) on the boundary stored by

tracking the boundary. Thus, by sequentially copying the pixel value of each coordinate of the line enclosed by the two points for each line, the image shown by (b) of Figure 4 is obtained. Simultaneously, when each pixel value is inverted and sequentially copied for each line, the inverse video as shown by (c) of Figure 4 is obtained. The outer boundary shown in (c) of Figure 4 corresponds to the inner boundary of (a) of Figure 4. Furthermore, by performing on the image of (c) of Figure 4 the same process as the process for obtaining (b) and (c) of Figure 4 from (a) of Figure 4, (d) and (e) of Figure 4 are obtained. However, (e) of Figure 4 is a practical result of extracting the area inside the inner boundary in (a) of Figure 4.

5) If no black pixels are included in the area inside the inner boundary obtained in 4), the process terminates. If they are included, 1) to 4) are repeated using the grandchild node as a parent.

(2) Topological Structure

Figure 5 shows a topological structure obtained as a result of performing the above-mentioned process on the image shown in Figure 1.

In Figure 1, the node at the first level indicates the entire image shown in Figure 1, and the nodes at the second level are a character node indicating a character area and a child node indicating a graphic area. Since the graphic area corresponding to the child node has a deep structure, the grandchild nodes 1 and 2 corresponding to the internal area extracted by the above-mentioned algorithm are generated as the third level. Furthermore, the processes are continuously

performed on the image of the area corresponding to the grandchild nodes, a character node is added below the grandchild node 1, and a character node and a child node indicating graphics are added as the fourth level below the grandchild node 2. Since there is no deep structure in the graphic area corresponding to the node at the fourth level, the process terminates here.

As described above, the structuring process to hierarchically separate a character area and a graphic area according to the gist of the present invention terminates. However, when the mixed mode communication is performed, it is necessary to follow the layout structure (document structure) including a page (p), a frame (F), and a block (B) regulated in the CCITT Recommendation T.73.

Therefore, described below is the procedure of converting the topological structure according to the present invention to the document structure regulated in the CCITT Recommendation T.73.

(3) Structure Conversion and Document Structure

1) Define the node of the root (first level) as a page, and a node positioned at an odd level and having no lower node is erased.

2) A node at an even level is defined as a block when it has no lower node. Otherwise, it is defined as a frame, and a block having as contents a result of obtaining an exclusive logical sum of a corresponding area and all nodes at one level lower is added to the level below the corresponding frame.

3) The node at an odd level is defined as a frame when the number of lower nodes is two or more, and erased when the number is one and the lower node is added below the upper node.

4) The top-down process 2) to 3) above is repeated on a structure tree. Figure 6 shows the result of converting the topological structure shown in Figure 5 to the layout structure in the procedure above. The node at the first level shown in Figure 5 is a page in Figure 6 by 1) above. Next, as for the node at the second level shown in Figure 5, the character node is determined as a block as is and the node having a graphic area is determined as a frame by 2) above in Figure 6. Simultaneously, the block having as the contents a result of obtaining an exclusive logical sum of the graphic area and the area of the two nodes (grandchild nodes 1 and 2) at the third level is added below the frame. Furthermore, the grandchild node 1 at the third level shown in Figure 5 is erased by 3) above, and the lower character node at the fourth level is added as a block below the above-mentioned frame. The grandchild node 2 is determined as a frame by 3) above. Finally, the character node at the fourth level below the grandchild node 2 and the child node are added as blocks by 2) above.

As described above, according to the present invention, the characters included in the graphic area can be efficiently and correctly separated by hierarchically separating the graphic area.

Described next is the configuration of the apparatus for hierarchically separating data.

Figure 7 shows the outline of the character/graphic separating system according to the present invention. An input unit 7 binarizes the image information input from a scanner (not shown in the attached drawings) at any level, and stores the binary information in built-in memory. A structure analysis unit 8 obtains structured data by analyzing the structure of an image as the feature of the present invention, and determining the media (characters and graphics). A character recognition unit 9 determines whether or not the character area separated by the structure analysis unit 8 is correct, and converts the character area into a character code when it is correct. An accumulation unit 10 accumulates structured data in a disk etc., and the output of the accumulation unit 10 is provided for printing, editing, and transmission.

The character recognition unit 9 is an existing technique, and is known by a publication "Introduction to Character Recognition" edited by Hashimoto, published by the Institute of Electronics, printed by Ohmsha, issued in March, 1982, etc. Therefore, the structure analysis unit 8 is described below in detail.

Figure 8 is a block diagram of the structure analysis unit 8. A boundary tracking unit 11 tracks a boundary of 8 pixels for a binary black and white pixel image, and stores boundary coordinate values. A character/graphics separation unit 12 determines characters and graphics depending on the size of a closed area extracted by the boundary tracking unit 11. Data storage units 13 and 14 store data in the character or graphic areas. An internal area extraction unit 15 extracts an internal

area of the graphic area determined by the character/graphics separation unit 12. An internal area extraction unit 15 extracts an internal area of a graphic area determined by the character/graphics separation unit 12. A termination determination unit 16 determines whether or not there is a black pixel in all extracted internal areas. A gate circuit 17 transmits the data stored in the data storage units 13 and 14 to the converter unit 18 when the termination determination unit 16 determines that no black pixels are detected in all internal areas and considers that the topology analysis has been terminated. A converter unit 18 converts a topological structure into a document structure (layout structure).

That is, the structure analysis unit 8 generates a closed area by the boundary tracking unit 11, and determines the closed area a character area or a graphic area depending on the size of the closed area. The character/graphics separation unit 12 separates the areas, checks whether or not a closed area is included in the separated graphic area. The internal area extraction unit 15 extracts the area. If a closed area is included in the graphic area, the boundary tracking unit 11 and the character/graphics separation unit 12 repeatedly separate the characters and the graphics as a structuring process as described above. Finally, the character areas and the graphic areas can be correctly separated.

In the description above, one document includes a graphic area for example. However, when a plurality of graphic areas are included, an internal area is sequentially extracted using one 15 and 16 for each graphic area, or a plurality of internal area

extraction units 15 and termination determination units 16 are provided so that the gate circuit 17 can be operated when no black pixel is detected in all closed areas.

Although an example of converting a topological structure into a document structure according to the CCITT Recommendation is described above, the present invention is not limited to this application, and the structure can be converted into any other document structures.

(Advantages of the Invention)

As described above, the present invention can extract a closed area by tracking a boundary of a black area in an image, and repeatedly analyzes the internal structure of the extracted closed area, thereby efficiently and correctly separating a character area and a graphic area. Therefore, the subsequent document edition can be easily performed, an mixed mode communication can be performed with high transmission efficiency and accumulation efficiency by appropriate coding data for each of the separated areas, thereby greatly enhancing the effect of the invention in reducing a necessary amount of image information and improving a transmission speed.

4. Brief Description of the Drawings

Figure 1 shows an example of a document having an internal structure for description of the conventional character/graphic separating system. Figure 2 is a block diagram of the flow of the character/graphic separating system according to the present invention. Figure 3 shows the criterion of characters and graphics according to the present invention. Figure 4 is an

explanatory view of the method of extracting an internal structure of a closed area according to the present invention. Figure 5 shows the topological structure according to the present invention. Figure 6 shows the conversion from a topological structure to a document structure according to the present invention. Figure 7 shows the outline of the character/graphic separating method according to the present invention. Figure 8 is a block diagram of the structure analysis unit according to the present invention.

7 ... input unit,

8 ... structure analysis unit,

9 ... character recognition unit,

10 ... accumulation unit,

11 ... boundary tracking unit,

12 ... character/graphics separation unit,

13, 14 ... data storage unit,

15 ... internal area extraction unit,

16 ... termination determination unit,

17 ... gate circuit,

18 ... converter unit.

Figure 1

#1 AREA A

#2 AREA B

Figure 2

1 DOCUMENT

2 CONVERSION INTO BINARY BLACK AND WHITE DATA

3 TOPOLOGY ANALYSIS

4 TOPOLOGICAL STRUCTURE

5 STRUCTURE CONVERSION

6 DOCUMENT STRUCTURE

Figure 3

#1 HEIGHT OF EXTRACTED AREA

#2 GRAPHICS

#3 CHARACTER

#4 MAXIMUM WIDTH OF TARGET CHARACTER

#5 MAXIMUM HEIGHT OF TARGET CHARACTER

#6 MINIMUM HEIGHT OF TARGET CHARACTER

#7 WIDTH OF EXTRACTED AREA

Figure 4

#1 OUTER BOUNDARY

#2 INNER BOUNDARY

#3 AREA WITH DIAGONAL LINES: BLACK PIXELS

#4 COPY OF PIXELS IN AREA INSIDE THE INNER BOUNDARY

#5 INVERT AND COPY PIXEL VALUE IN AREA INSIDE THE OUTER BOUNDARY

Figure 5

#1 PARENT NODE

#2 CHARACTER NODE

#3 CHILD NODE

#4 GRANDCHILD NODE

#5 FIRST LEVEL

#6 SECOND LEVEL

#7 THIRD LEVEL

#8 FOURTH LEVEL

Figure 6

#1 PAGE

#2 FRAME

#3 BLOCK

Figure 7

#1 INPUT

7 INPUT UNIT

8 STRUCTURE ANALYSIS UNIT

9 CHARACTER RECOGNITION UNIT

10 ACCUMULATION UNIT

Figure 8

#1 INPUT

9 CHARACTER RECOGNITION UNIT

11 BOUNDARY TRACKING UNIT

12 CHARACTER/GRAPHICS SEPARATION UNIT

13 DATA STORAGE UNIT

14 DATA STORAGE UNIT

17 GATE CIRCUIT

18 CONVERTER UNIT

15 INTERNAL AREA EXTRACTION UNIT

16 TERMINATION DETERMINATION UNIT

ておき、すべての閉領域に黒画素がなくなったことを検出した時点でゲート回路17を動作させるようにしても良い。

また、トポロジカル構造をCCITT勧告のドキュメント構造に変換する場合を例にとり説明したが、これに限定されることなく他のドキュメント構造に変換しても良い。

（発明の効果）

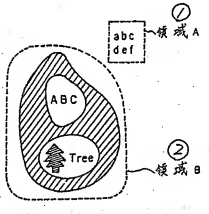
以上のように本発明は画像中の黒領域の境界追跡により閉領域を抽出し、抽出された閉領域の内部構造を繰り返し解析することにより文字領域と図形領域とを効率良く、かつ正確に分離することができる。従って、以後の文書編集も容易となり、かつ分離領域毎に適した符合化により伝送効率及び蓄積効率の優れたミクストモード通信が可能となり画像情報量の低減及び伝送速度の向上の点で発明の効果が極めて大である。

4．図面の簡単な説明

第1図は従来の文字・図形分離方式を説明するための内部構造をもつ文書例、第2図は本発明による文字・図形階層的分離方式の流れを示すブロック図、第3図は、本発明による文字・図形の判別基準を示す図、第4図は、本発明による閉領域の内部構造の抽出方法を説明するための図、第5図は本発明のよるトポロジカル構造図、第6図は本発明によるトポロジカル構造をドキュメント構造に変換した変換図、第7図は、本発明による文字・図形階層的分離方法の概略図、第8図は本発明のよる構造解析部のブロック図である。

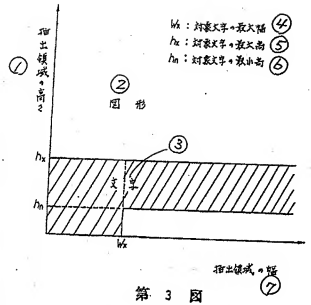
7…入力部、　8…構造解析部、
9…文字認識部、10…蓄積部、
11…境界追跡部、12…文字・図形分離部、
13，14…データ記憶部、
15…内部領域抽出部、
16…終了検出部、17…ゲート回路、
18…コンパレータ部。

特許出願人
国際電信電話株式会社
特許出願代理人
弁理士　山　本　恵　一

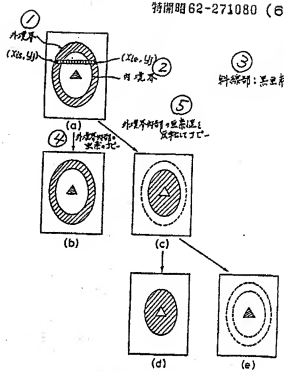


第　1　図

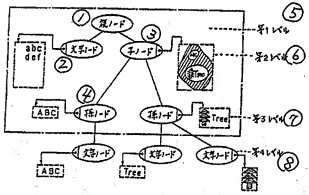
第　2　図



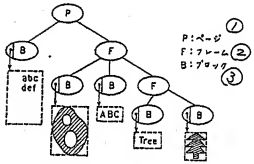
第 3 図



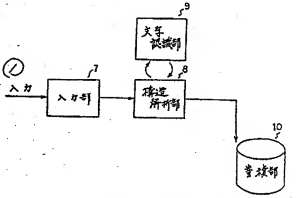
第 4 図



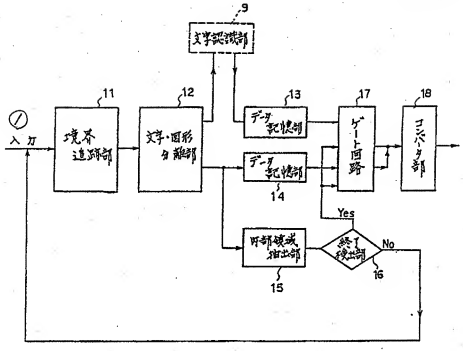
第 5 図



第 6 図



第 7 図


9
文字認識部
11
境界追跡部
12
文字・図形分離部
13
データ記憶部
17
ゲート回路
18
コンパータ部
入力
データ記憶部
14
Yes
No
内部破戒検出部
15
終了検出部
16

第 8 図